BIOTELEMETRY:

- Biotelemetry is the use of the telemetry methods in order to remotely observe, document and measure certain physiological functions in human beings.
- Telemetry is a technology that allows remote measurement and reporting of information. The word is derived from Greek roots *tele* = remote, and *metron* = measure.
- Biotelemetry is the electrical technique for conveying biological information from a living organism and its environment to a location where this information can be observed or recorded. Thus it refers the communication between a living system and an observer.
- Biotelemetry is extended for monitoring patients in a hospital from a remote location, for monitoring patients who are on the job or at home and carrying implanted pacemaker or other stimulators.
- Medical telemetry is particularly important because it can be used to remotely track the vital signs of ambulatory patients.
- Biotelemetry system used for the purpose of measuring the functions like body temperature, heart rate, blood pressure, and muscle movement.
- Although the term commonly refers to wireless data transfer mechanisms (e.g.using radio or infrared systems), it also encompasses data transferred over other media, such as a telephone or computer network, optical link or other wired communications.
- Many modern telemetry systems take advantage of the low cost and ubiquity of GSM networks by using SMS to receive and transmit telemetry data.

- Bio telemetry is the measurement of biological parameters over long distance.
- For conveying biological information from a living organism and its environment to a different location where this can be recorded.

Elements of Biotelemetry System:

- The essential blocks of a biotelemetry system is shown in figure.
- The transducer converts the biological variable into electrical signal.
- The signal conditional amplifies and modifies this signal for effective transmission.
- The transmission link connects the signal input blocks to the readout device by wire or wireless link.

- ECG,EEG,EMG- Electrodes act as transducer
- For measuring temperatures-Thermistor is used as transducer
- For measuring blood pressure-strain gauge is used as transducer
- For measuring stomach pH-glass electrode is used as transducer.

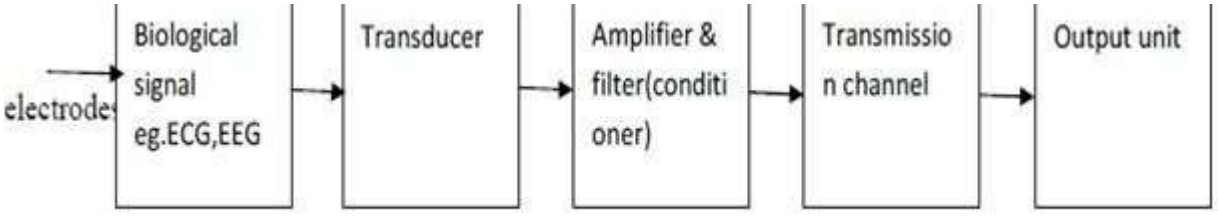


Fig: 4.6.1Block diagram of Biotelemetry system

[Source: Khandpur, R.S., —Handbook of Biomedical Instrumentation]

DESIGN OF BIO TELEMETRY:

- Telemetry system should be selected to transmit the bio –electric Signal with maximum fidelity and simplicity.
- The system should not affect the living system by any interference.
- Smaller in size light in weight.
- It should have more stability and reliability.
- The power consumption at the transmitter and receiver should be small.
- It should reject common mode interference rejection.
- Miniatured radio telemetry system should be used to reduce noise.

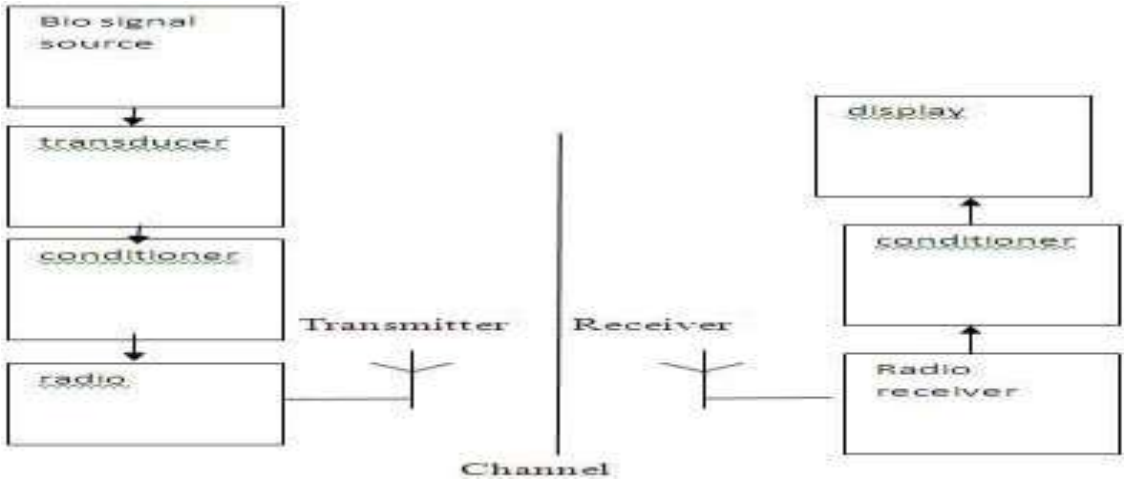
RADIO TELEMETRY SYSTEMS:

- Single channel telemetry system
- Multi channel telemetry system

SINGLE CHANNEL TELEMETRY SYSTEM

- For a single channel telemetry system, a miniature battery operated radio transmitter is connected to the electrodes of the patients.
- The transmitter broadcasts the biopotential to a remote place in which the receive detects the radio signal and recovers signal for further processing.
- The receiving system can be located in a room separately from the patients.

- The only risk is electrical shock to the patient is due to the battery powered transmitter itself. Since it is kept low there is negligible risk to thepatient.
- The biosignals are amplified to radio frequency range of few hundred KHz to about 300 KHz and then they are transmitted by transmitter antenna.



- Further the amplitude modulation is not adapted because when relative motion occurs between the transmitter and receiver, the signal amplitude will be varied and thus introduces serious errors. Thus to adapt that we use either frequency modulation or pulse modulation technique to transmit the bio signals.

Transmission of bioelectric variables:

- In a single channel telemetry system, the measurements are made under of the two categories:

➢ Active measurements

➢ Passive measurements

Active measurements: Here the bioelectric variables like ECG, EMG and EEG are measured directly without using any excitation voltage.

- **Passive measurements:** Here the physiological variables like blood pressure, temperature, blood flow, etc are measured indirectly using transducers and excitation voltages.

Tunnel diode FM transmitter:

- The tunnel diodes exhibit a specific characteristics known as negative resistance.
- They have extremely low values of inductance an capacitance.
- It is used for the transmission of EMG,ECG, respiration rates.
- Tunnel diodes are used as active devices and this circuit has higher fidelity and sensitivity.
- Total weight is 1.44 gm with battery and the size is small.
- Varactor diode is basically a reverse biased PN junction which utilizes the - inherent capacitance of depletion layer.
- Varactor diodes are voltage capacitors used for frequency modulation.
- The signal is transmitted through the inductor L of the tank circuit of RF oscillator.

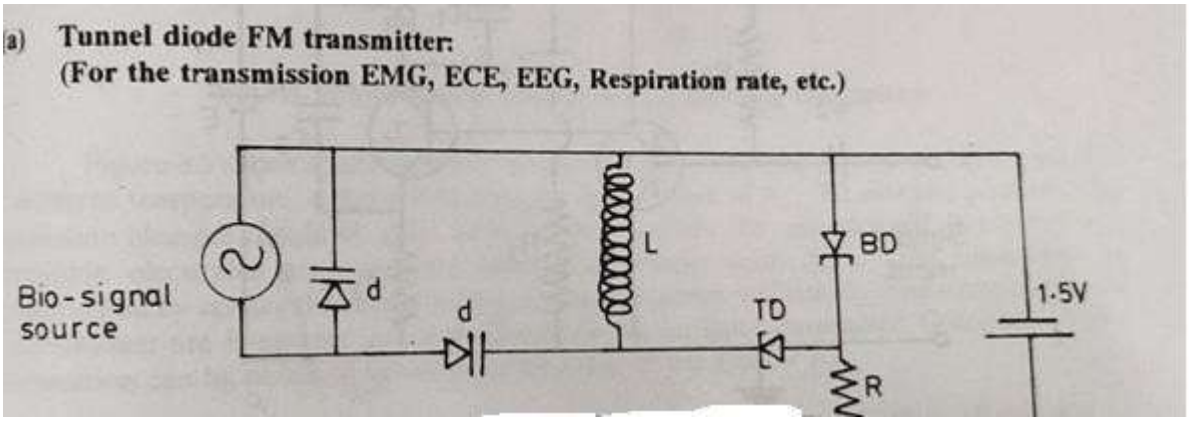


Fig. 4.6.2: Single channel FM Transmitter

[Source: Khandpur, R.S., —Handbook of Biomedical Instrumentation]

Advantages:

- All the signal can be transmitted by using the circuit.
- No shielded room is needed.
- Interference is much reduced.

Hartley type FM transmitter:

- This method is used foe transmission of ECG, EEG and EMG.
- LC is tank circuit to generate the signal which is used for oscillation and a specified frequency can be designed: Bandwidth of the signal varied from 100 Hz to 1 KHz.

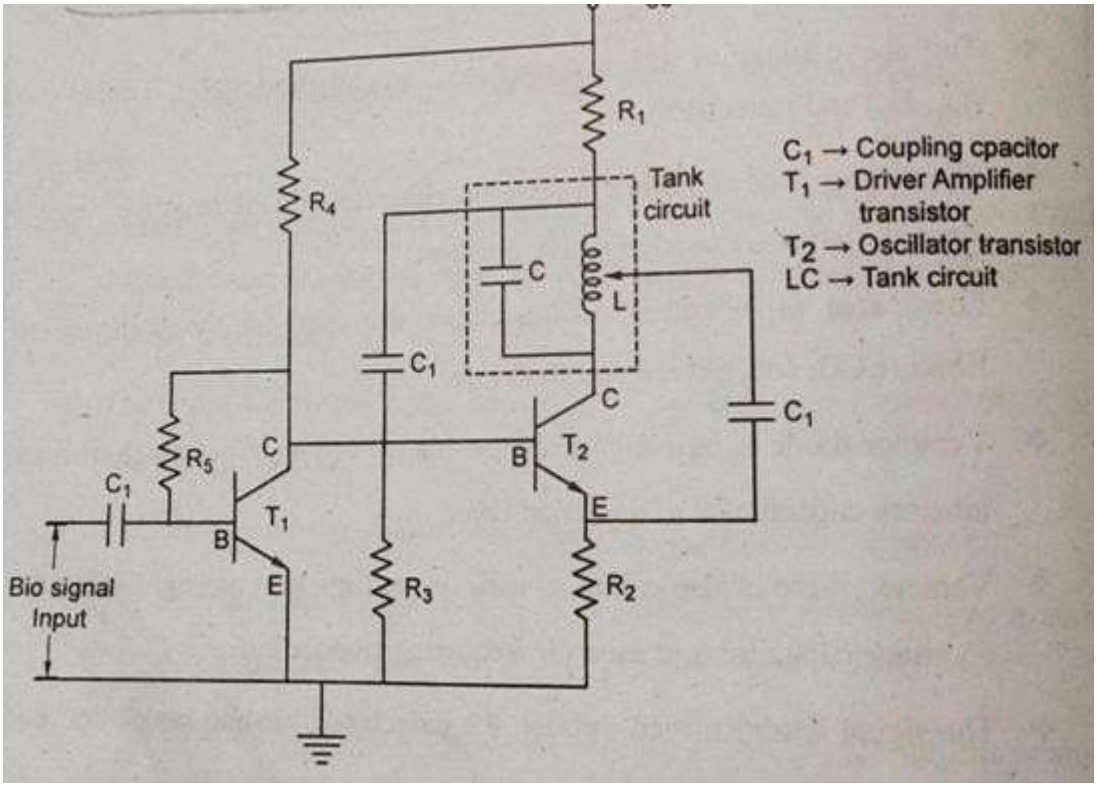


Fig.4.6.3: Hartley type FM Transmitter

[Source: Khandpur, R.S., ―Handbook of Biomedical Instrumentation]

Pulsed Hartley oscilator:

- This method is used for the transmission of temperature signals, pressure continuously for long periods.
- The transmitter is modulated by varying the rate of pulses of radio frequency oscillations. The transducer and conditioner are integrated into components of the oscillator-transmitter. Continuous wave operation can be obtained by reducing the value of the resistor R1
- The circuit is so simple and has low power consumption 5microW to 10 microW. Bit in the pulsed mode operation, large error can be produced by the power supply voltage variations,
- Interference can be generated over wide frequency band because of self blocking pulsed carrier mode operation.

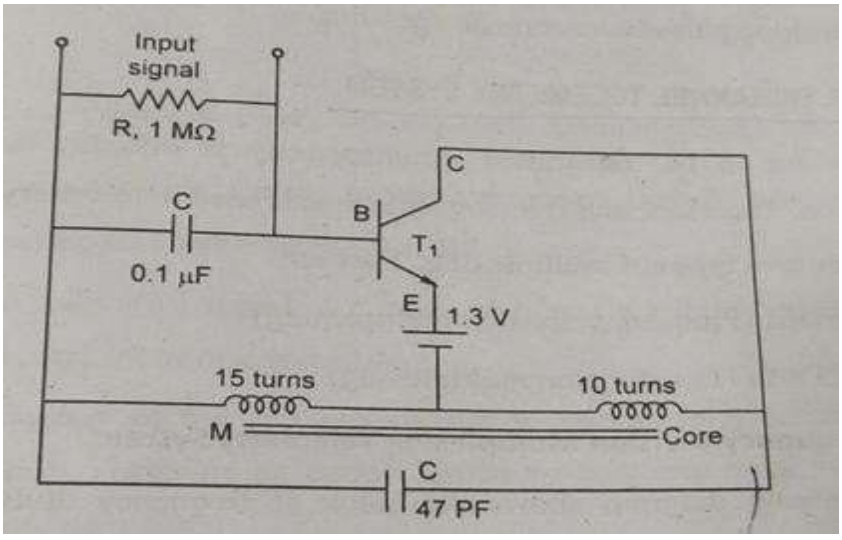


Fig:4.6.4 .Pulsed Hear tly Oscillator

[Source: Khandpur, R.S., ―Handbook of Biomedical Instrumentation]

MULTI CHANNEL TELEMETRY SYSTEM:

- For most biomedical applications, simultaneous recording of Bio signals are required for correlation study.
- Each signal is in need of one channel. When the number of channels is more than the two or three, the simultaneous operation of the several single channel is difficult. At that time multiple channel telemetry system is adopted**.**
- **Two types of multiplexing:**

I) Frequency Division Multiplex (FDM)

II) Time Division Multiplex (TDM)

Frequency division multiplex system:

- Each signal is frequency modulated on a sub carrier frequency.
- Modulated sub carrier frequencies are combined to modulate the RF carrier.
- At receiver the modulated sub carrier can be separated by the proper band pass filter.
- Then the each signals are demodulated by using specified frequency.
- Frequency of the sub carrier has to be carefully selected to avoid interference.
- The low pass filter are used to extract the signals without any noise. Finally the output unit displays the original signal

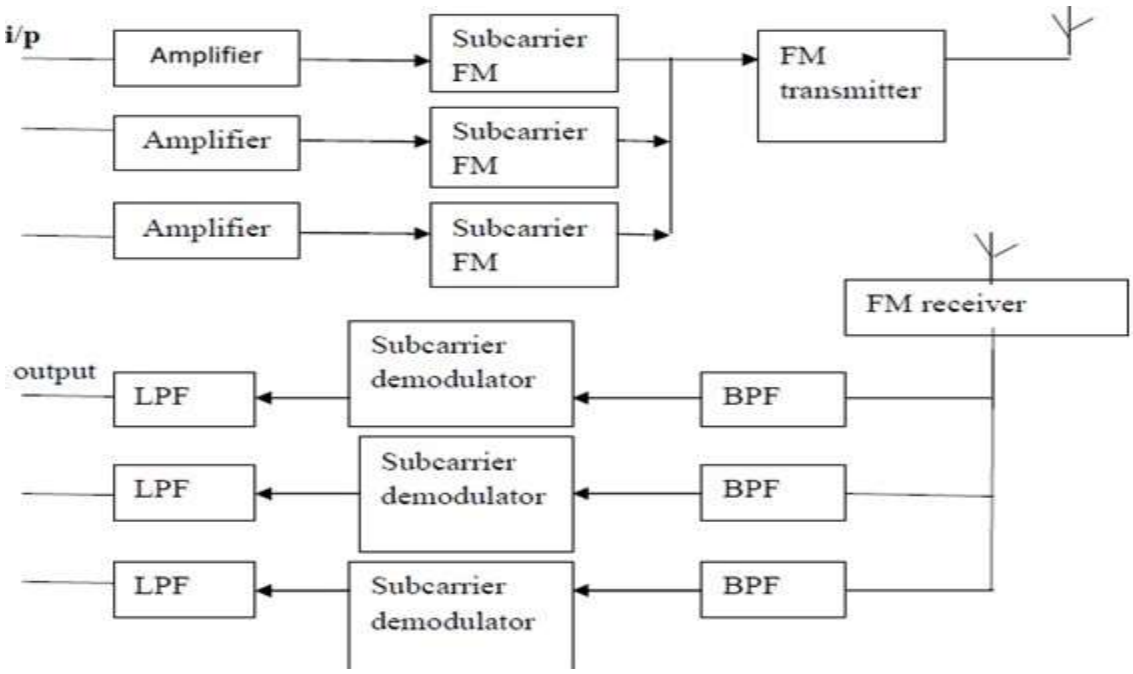


Fig:4.6.5 Frequency Division Multiple access system

Time division multiplex telemetry system:

- Most biomedical signals have low frequency bandwidth requirement, we can use time division multiple system by time sharing scheme.
- Transmission channel is connected to each signal channel input for a short time to sample and transmit that signal.
- Transmitter is switched to the next input signal channel in a definite sequence.
- All the channels have been scanned once, a cycle is completed and the next cycle will start. Scanning follows a order from signal 1 to signal 3.
- At the receiver the process is reversed. The sequentially arranged, signal pulses are given to the individual channels by using gate signal generator.
- If the number of scanning cycles per second is large and if the transmitter and the receiver are synchronized, the signal in each channel at the receiver side

can be recovered. But the scanning frequency fn has to satisfy the following condition i.e) The scanning frequency fn should be atleast greater than twice the maximum signal frequency fs .fscan >2fmax

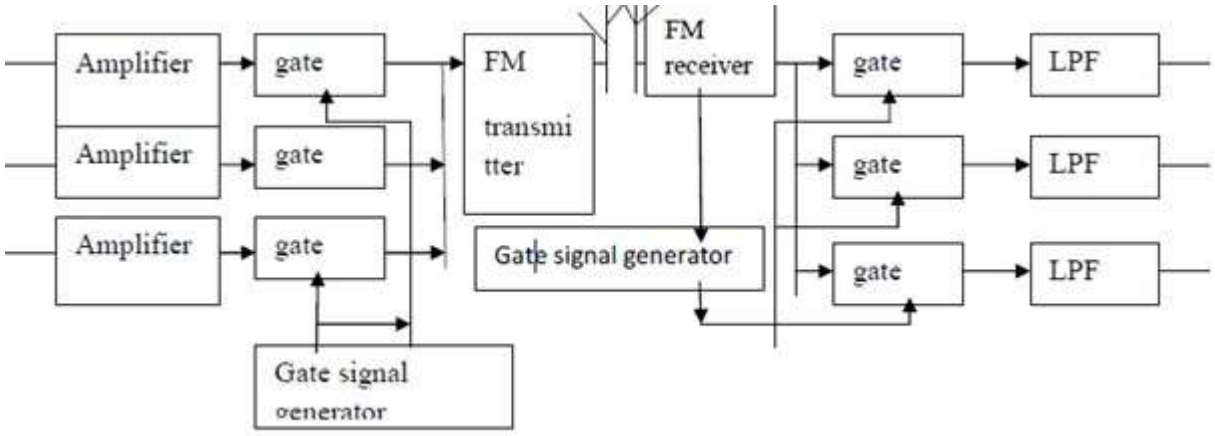


Fig:4.6.6Time Division Multiple Access system

Advantages of biotelemetry:

- Used to record the biosignals over long periods.
- Patient is not disturbed during recording
- For future reference or to study the treatment effect
- Monitor the athletes running a race.
- For monitoring the persons who are in action the biotelemetry is an ideal one.
- For recording on animals, particularly for research , the biotelemetry is greatly used.

DIATHERMY

Definition: Diathermy is the treatment process by which cutting, coagulation of tissues are obtained.

- Application of high-frequency electromagnetic energy
- Used to generate heat in body tissues
- Heat produced by resistance of tissues
- Also used for non-thermal effects

Types of diathermy

- Shortwave diathermy
- Ultrasonic diathermy
- Microwave diathermy
- Surgical diathermy

Physiologic Responses to Diathermy

- Not capable of producing depolarization and contraction of muscles
- Wavelengths too short
- Physiologic Effects Are Those of Heat In General
- Tissue temperature increase
- Increased blood flow(vasodilatation)
- Increased venous and lymphaticflow
- Changes in physical properties of tissues

- Muscle relaxation
- Analgesia
- Diathermy is the treatment process by which cutting, coagulation of tissues are obtained.
- Diathermy is a form of treatment in physical therapy that uses electromagnetic current at high frequencies and low frequencies.
- High-frequencies of heat tissues located at different depths.
- Low frequencies heat is typically used to relieve a patient from muscle pain and repair of tissues that suffered from lesions (wound or injury).
- Diathermy treatment is generally painless and the target is to recover the damaged tissue with heat to relax the tight tissue, to increase the blood flow, and reduce swelling

- This form of thermal therapy is typically used to treat muscle spams or tension, stiff joints and muscle joint.
- Used to generate heat in body tissues

Advantages:

- Treatment can be controlled easily.
- Use of appropriate electrodes permit the heat to be localized only in the region to be treated.
- Amount of heat that is to be delivered can be adjusted accurately.
- Inter lying tissues, muscles, bones, internal organs, etc, can be provided with heat by using high frequency

Microwave Diathermy

- In this method the tissues are heated by the absorption of microwave energy.
- Microwave diathermy treatments is highly focused electromagnetic radiation, emitted from an instrument shaped like a stick at the damaged area.
- This form of diathermy is best use for more localized injuries or small muscles.
- Microwave diathermy treatments last about 20 to 30 mins.
- It consists of a power source that sends electrical current into a magnetron, a tube-like structure with exterior magnets.
- The machine cabinet are one (or) two adjustable arms, each having an end applicator which has a flat surface on one side that acts as an antenna through which the microwave travel.
- Microwave diathermy is very simple, generally two designs of applicators are common.
- 1. Circular: Used for small (or) large areas with different shed applications.
- 2. Rectangular: For enlongated areas.
- The frequency used is about 2450 MHz.

  Better results are obtained by the microwave method and it is more advantageous than the short wave method.
- There is no pad electrodes and flexible cable.

- Microwave is transmitted into body and treat directly from the direction of unit.
- Microwaves are produced with the help of magnetron.
- Proper cooling arrangements are made for the purpose of cooling the magnetron.
- No tuning is necessary for individual treatments.

Precautions:

- Necessary precautions should be taken during this method of treatment
- Excessive dosage causes skin burns and the skin should be dry as the waves are rapidly absorbed by water.

Advantages

- This type of remedy used to treat rigid joints and joint pains often associated with arthritis without using electrodes and cable.
- Accelerate the healing of an injured area.
- Proper coding arrangements are made for the purpose of cooling the magnetron.

Disadvantages

- Patients with implanted pacemaker should not undergo this treatment
- There are possibilities of over heating
- Care should be taken while the treatment is made near the eyes**.**

SHORTWAVE DIATHERMY

- The heating of tissues is carried out at a high frequency of 27.12 MHz and a wavelength of 11 m.
- This form of diathermy is able to warm large area of tissue and is used to treat large muscle problems.
- The output of R.F oscillator is applied to the pair of patient electrodes.
- The R.F energy heats the tissues and promotes the heating of injured tissues and inflammations.
- The power delivered is about 500w. The electrodes or pads are not directly contact with skin. Usually layers of towel are interposed between themetal and surface of body.
- The pads are forming capacitor plates and the body tissues between the pads act as dielectric. Thus the whole arrangement forms a capacitor.

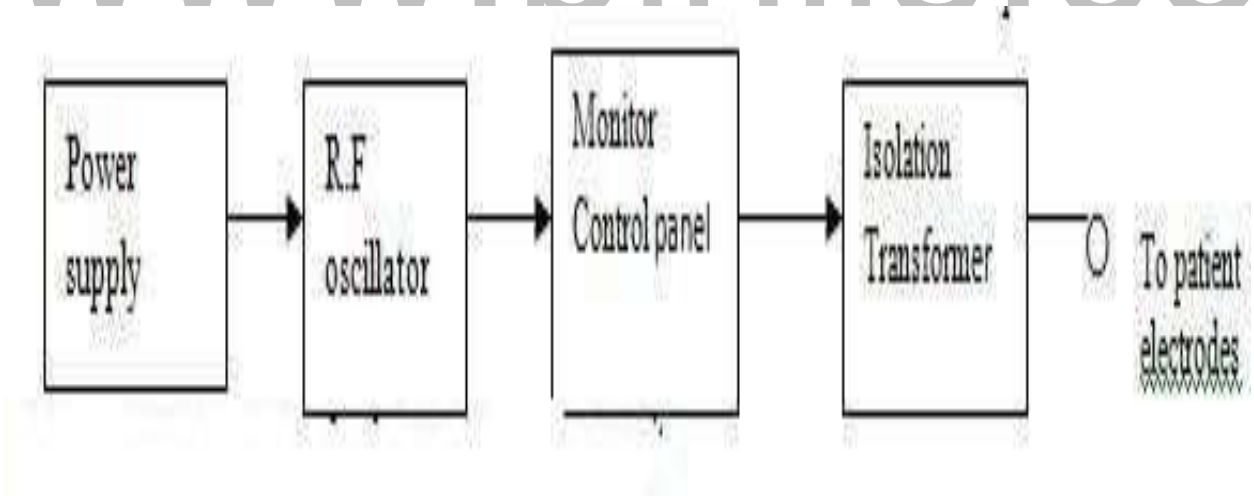


Fig: 5.2.1 Block diagram of short wave diathermy unit

[Source: Khandpur, R.S., ―Handbook of Biomedical Instrumentation]

Fig:5.2.2 Short wave diathermy unit

[Source: Khandpur, R.S., ―Handbook of Biomedical Instrumentation]

- When R.F current applied to the pads, the dielectric loss of the capacitor produces heat in the intervening tissues. This technique is called **condenser or capacitor method**.

- **In inductive method**, a flexible cable is coiled around the arm. When R.F current is passed through the cable.

- Deep heating in the tissue results from electrostatic field set up between its ends and heating in the superficial tissues is obtained by eddy currents set up by magnetic field around the cable.

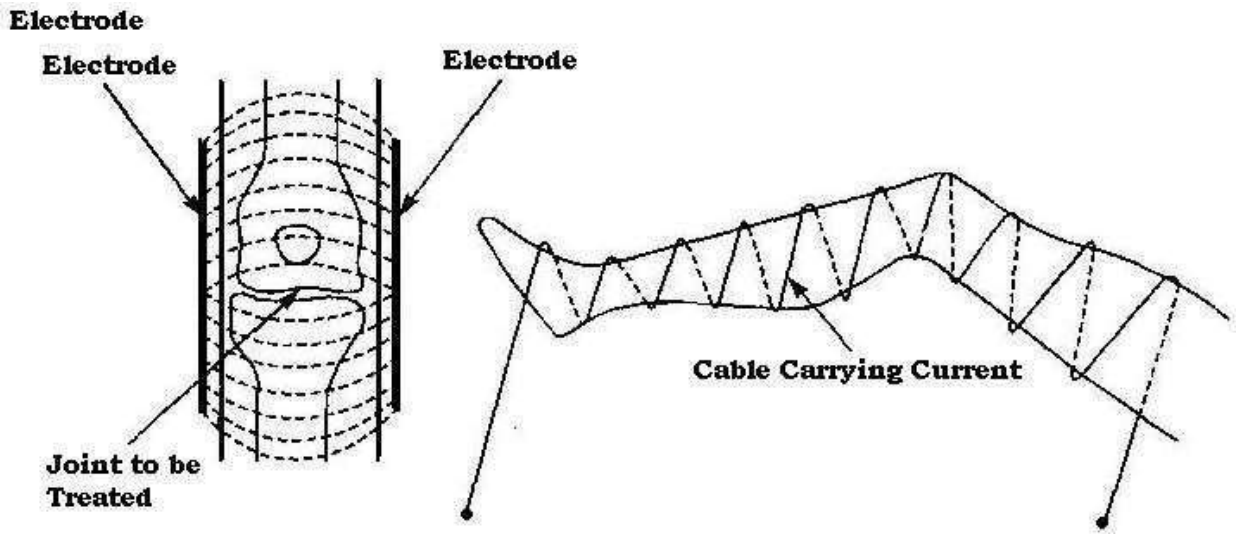


Fig: 5.2.3 **short wave diathermy capacitive and inductive method**

[Source: Khandpur, R.S., —Handbook of Biomedical Instrumentation]

- Instead of continuous R.F wares, R.F pulses of 65 µs with on interval between pulses of 1600 µs are also used. This is called Dia-pulse shortwave diathermy.
- The rate of pulsation is from 80 to 600 pulses/ sec with peak power of 293 to 975 w. By this methods the excess tissue fluid associated with Cellular damage is reduced, Heating rate is enhanced, No danger of burns, the depth of penetration is correctly adjusted.
- People with metal implants or pacemakers should not refer this treatment because metal might increase the amount of heat and cause burns.
- Also not recommended for patients with unstable BP, heart diseases or kidney disorder.
- Should not be apply to the patient who had open wounds, because burning might be occur.

Surgical Diathermy

Logic board is the main part of the unit which produces the necessary waveforms

for cutting, coagulation and hemostasis modes of operation.
An astable multivibrator generates 500 kHz square pulses. The output from this oscillator is divided into a number of frequencies using binary counters.
These frequencies are used as system timing signals , A frequency of 250 KHz provides a split phase signal to drive output stages on the power output board.
Frequency of 250 Hz is used for cutting , after the high power amplification by push pull amplifier.
The output of the push pull amplifier is given to a transformer so that the voltage is stepped up and the output signal from the unit is well isolated.
The isolator switch provides an isolated switching control between the active hand switch and the rest of the unit.
The various electro surgery techniques using diathermy unit are

1.Fulguration

When the electrode is held near the tissue without touching it and due to the passage of electric are, destruction of superficial tissues take place. It is related to the localized surface level destruction of tissues. Needle or Ball electrodes are used.

2.Desiccation

The needle point electrodes are stuck into tissue, while passing electric current a local increase in heat creates drying of tissues. This is called desiccation which produces dehydration in tissues.

3. Electrotomy

When the electrode is kept above the skin, an electrical are is sent. The developed heat produces a wedge shaped cutting of tissue on surface. Continuous R.F current is used for cutting

4. Coagulation

When the electrode is kept above the skin, high frequency current is sent through the tissues in the form of bursts and heating it locally so that it coagulates from inside. The concurrent use of continuous R.F current for cutting and a R.F wave burst for coagulation is called Hemostasis mode.

5. Blending

When the electrode is kept above the skin, the separated tissues can be combined together by an electric arc. This is called blending. Logic board is the main part of the unit which produces the necessary waveforms for cutting, coagulation and hemostasis mode of operation. An astable multivibrator generates 500 KHz square pulses. The outputsdivided into a number of frequencies using binary counters. These frequencies are used as system timing signals. A frequencies of 250 KHz provides a split phase signal to drive output stage on power output board. A frequency of 50 KHz provides a gating signal for making coagulatin g output.

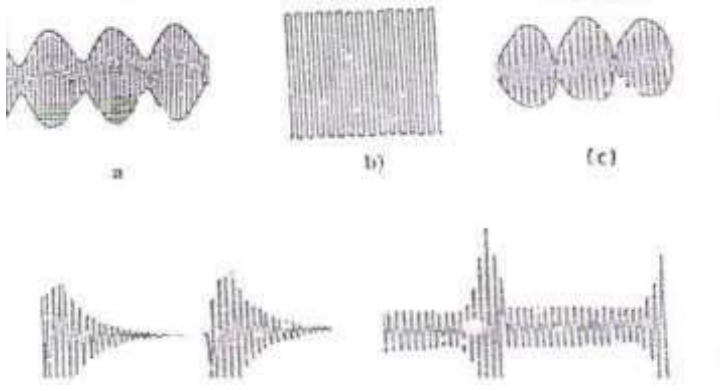


Fig 4.5.1: Different types of waveforms used in electrosurgical diathermy unit

[Source: Khandpur, R.S., —Handbook of Biomedical Instrumentation]

The frequency of 250 KHz is used for cutting. To indicate each mode of operation, diathermy unit is provided with an audio tone generator. When coagulation output is delivered, 1 KHz audio signal is heard. Similarly 500 Hz for cutting and 250 Hz for hemostasis.

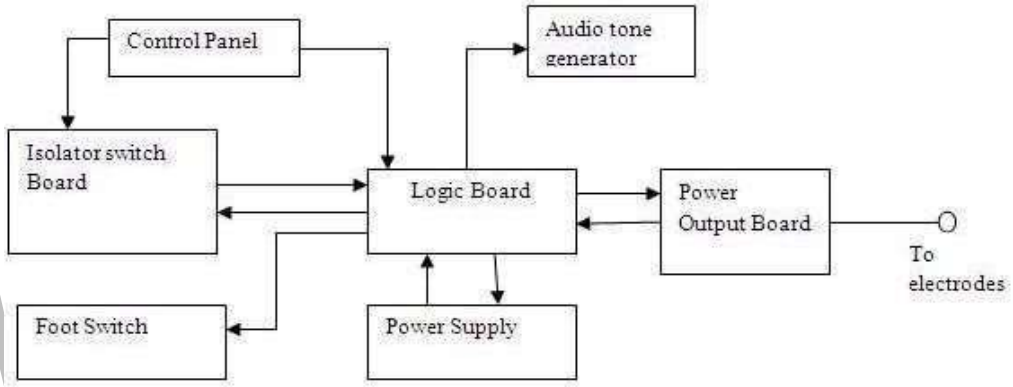


Fig4.5.2: Block diagram of electrosurgical diathermy unit

[Source: Khandpur, R.S., —Handbook of Biomedical Instrumentation]

The isolator switch provides an isolated switching control between the active hand switch and rest of unit. The foot switch is used to avoid any explosion formed by the an aesthesia gases near electrical contacts.

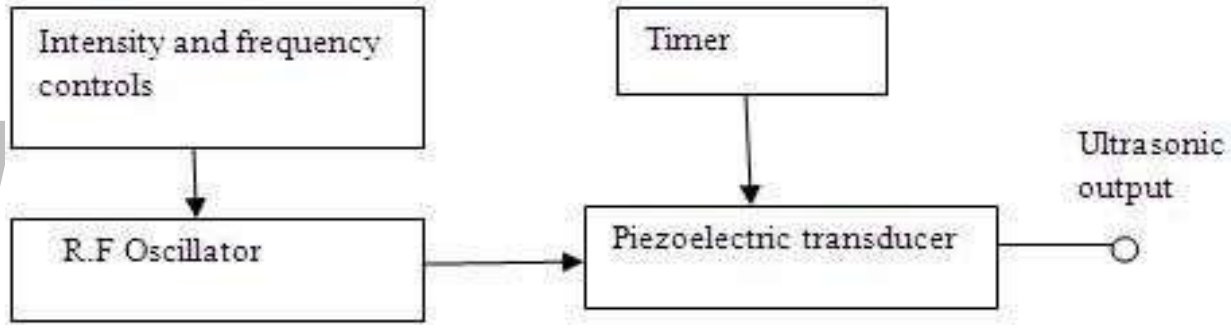
Special Features

- To secure safety for the patient or operator, the output unit is isolated and insulated from the low frequency primary and secondary voltages.
- The bipolar electrodes are used such that the active electrode is mounted in an insulated handle and in different electrode is placed at the back of patient in the form of plate.

- The output of the unit may be earth referenced or isolated. The isolated output dose not produce any fibrillation and any serious burns.
- The active electrodes for cutting are in the form of needle electrode and the active electrode for coagulation are in the form of a ball or plate.
- These are circuit integrity monitors like patient circuit continuity monitor, alternate path current monitors etc.
- The frequency of operation is from 20 KHz to 1 MHz. The output power for cutting is about 400 w and for coagulation is 150 w.

Ultrasonic diathermy

- Ultrasonic therapy is used where short wave treatment is failed and where localization of heat effect is desired.
- It is very helpful to cure the diseases of peripheral nervous system.
- The heating effect is produced due to the absorption of ultrasonic energy by the tissues.
- The effect of ultrasonic on the tissues is a high speed vibration of micro massage. Micro massage is used in the treatment of soft tissue lesions.



- Ultrasonic massage is better because of greater depth of massage can be obtained without any pain to the patient

Fig: 5.3..1Block diagram of an Ultrasonic diathermy unit

[Source: Khandpur, R.S., ―Handbook of Biomedical Instrumentation]

- R.F oscillator produces a high frequency alternating current which excites the piezo electric transducer.
- The ultrasonic waves can be applied in contained or pulsed mode. In case of pulsed mode, micro massage is obtained effectively without any thermal effect.

- In front of crystal, there is a metal face plate which is made to vibrate by the oscillations of crystal. Ultrasonic wave are emitted from this plate.
- The amount of ultrasonic energy absorbed by the tissues is depending upon the frequency of ultrasonic waves.
- The frequency ranges from 800 KHz to 1 MHz and the output power can be varied from 0 to 3 w/cm2. The treatment timer is an electrically operated contact which can be set from 1 to 15 min. It switches off the output power often the present time.
- The transducer probe is in direct contact with the body through an electrode gel.
- In case of large areas to be treated, the probe is moved up and down to obtain uniform distribution of ultrasonic energy. If there is a wound, the treatment is carried out in a warm water both to avoid the mechanical contact with the already injured tissues.

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